Profitability and conservation on a small scale

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by

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ABSTRACT

Like all things, the agriculture industry has advanced throughout time, whether through improved understanding or technology to overcome problems, such as profitability, which is currently a huge concern in the industry. A potential approach to overcome profitability issues while maintaining sustainability is to manage farm land at a much smaller scale than at a farm or even field level. This project aims to understand how using a yield raster map at a sub acre level and applying financial input data can create useful detailed high-resolution profit maps that can be used to increase future profitability. Using two years of harvest and input data for corn and soybeans on a particular cooperator's farm, the results indicate that soybean fields were unprofitable with both $9.00 and $11.00 commodity prices. However, corn had more favorable economics than soybeans, and at the higher commodity price of $5.50 was almost always profitable at the field scale. Results also showed that there were parts of fields that were unprofitable no matter what commodity price was used in the analysis. By avoiding row cropping the unprofitable areas and thereby eliminating the variable cost of production on those parts of fields, the overall profitability increased, even though these areas were not being farmed. Managing fields in smaller scale units than an entire field allows producers to capture opportunities for profitability while increasing conservation if unprofitable areas are seeded to perennial grasses, for example. Eliminating production costs in areas that are consistently unprofitable and utilizing those areas for conservation practices can create a win-win situation not observed when fields are managed as a single homogeneous unit.

CHAPTER I

INTRODUCTION

The agricultural industry has changed drastically through time from using hand tools, to using GPS guided tractors, and using seed saved from the best-looking plants, to using advanced genetic germplasm. There was little to no pest control early on, and today we have advanced genetic manipulation to enhance pesticide control; and we have gone from little concern about the environment to environmental stewardship being a top priority, to name a few changes occurring. Agricultural diversity has also shifted, from managing numerous types of crops and animals to more specialized production, where the focus may be on crops only or animals only, even going so far as to focusing on just one or two crops, which is corn and soybeans in Iowa. The USDA NASS data from 1993 shows that 42% of all planted field crop acres were corn and soybeans compared to 56% in 2016 across the United States, thus showing an increase in cropping specialization (United States Department of Agriculture, 2017). With these types of changes, the mindsets have changed addressing bigger scale, i.e. field economic performance, to individual acre performance. With the possibility of environmental stewardship being enforced and mandated by the government and profitability margins dwindling, it is time to change mindsets again. We need to focus on improvements on small areas that increase the overall conservation and economic performance of the field. By changing our way of thinking, many small improvements do substantially add up favorably across the field, farm, region, and eventually world.

CHAPTER II

BACKGROUND

A big challenge to the global population is producing enough food while protecting and maintaining environmental quality, as well as maintaining a positive economy for rural communities (Davis, 2012). Understanding the relationship between conservation and profitability allows for creating solutions to this challenge, especially in rural communities. Conservation agriculture's goal is to make better use of resources through management of available soil, water, and biological resources, combined with limited external inputs (FAO, 2001). When using conservation agricultural concepts over time, profitability tends to increase relative to that of conventional agriculture (FAO, 2001). Making better use of the land/soil resources available to the producer is important for long term environmental and financial sustainability. Land for which most producers have access typically varies from highly productive to that which is considered marginal for row crop production. With this is mind, marginal land is more vulnerable to degradation when managed incorrectly, especially with a continuous management scheme (Committee, 1997). Even with more advanced management options such as tile drainage, fertilizer, and other advanced technological inputs, the land is vulnerable to lost productivity; some of the marginal land could be classified as fragile in that it is more sensitive to certain management practices that speed up degradation (Committee, 1997).

All land is subject to some level of erosion; however, as steepness and length of slope increases runoff velocity and sediment movement increase. Over time, erosion hurts yield potential and soil productivity by removing topsoil which contains most of the soil profiles organic matter, and which may hold up to 50% of plant-available phosphorus. Similarly, potassium and nitrogen have complementary relationships with organic matter and consequently, the loss of topsoil decreases potential crop yield on those lands (Miller and Tidman, 2001). Addressing conservation and profitability benefits the producer, local communities, national/regional communities, as well as the global community. Some of the benefits and scale of the benefits can be seen in table below.

Benefits of Conservation Agriculture			
Benefits	Incidence Level		
	Locally	Nationally	Globally
Reduction in on farm costs: savings in time, labor, and mechanized machinery	x		
Increase in soil fertility and retention of soil moisture, resulting in long term yield increase, decreasing yield	x	x	x
Stabilization of soil and protection from erosion leading to reduced downstream sedimentation		x	
Reduction in toxic contamination of surface water and groundwater		x	
More regular river flows, reduced flooding and the re-emergence of dried wells		x	
Recharge of aquifers as a result of better infiltration		x	
Reduction in air pollution resulting from soil tillage machinery		x	x
Reduction of C02 emissions to the atmosphere			x
Conservation of terrestrial and soil based biodiversity			x
Adapted from the Food and Agriculture Organization of the United Nations. 2001. The economics of conservation agriculture.			

Table 1: Benefits of conservation agriculture and their incidence level.

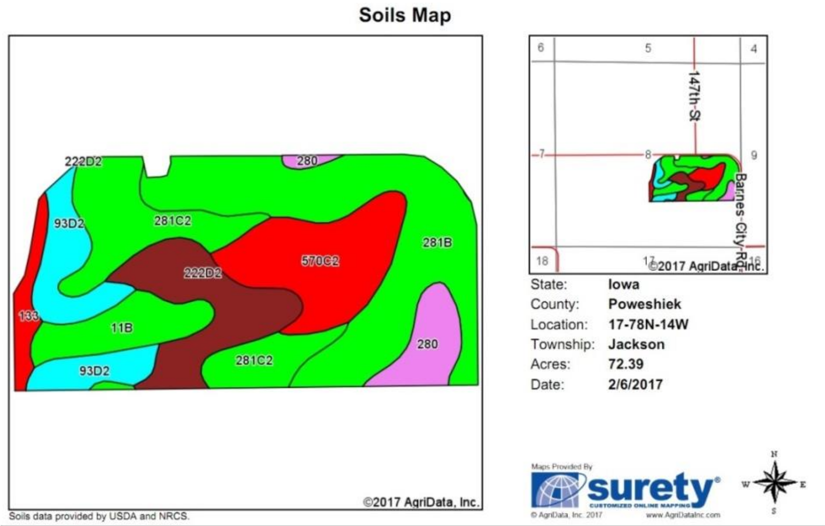
Society placing more value on conservation and responsible business practices impacts the way the food market, consumers, and producers do business. Consumption is no longer a passive acquisition of stuff; consumers are willing to pay more for food that is produced responsibly, supports responsible business practices, and supports those who practice environmental responsibility (Pierce, 2017). The implications of conservation and profitability on a small scale may have greater impacts than what has been previously understood.

CHAPTER III

FACOTORS OF PROFITABILITY AND CONSERVATION

Land Use

There are several key factors that affect agricultural conservation and profitability. How land use is allocated and approach to allocation directly affects land use change, and profitability. In the United States, four major land uses receive conservation treatments: cropland, forestland, pastureland, and rangeland. Conservation treatments on these lands address soil, water, air, plant and animal resources. In order to determine the land use and the effects it has on environmental resources, the USDA (2015) uses a system called Land Evaluation and Site Assessment (LESA). "LESA is a system for combining soil quality factors with other external factors such as agricultural use of a site, development pressures, and other public value factors that affect the importance of the site for continued agricultural use. Soil quality factors are grouped under Land Evaluation (LE) and external factors are grouped under Site Assessment (SA)" (Pease, 1996). National and local NRCS offices use this system to help determine the appropriate land use for a particular piece of land. LE factors establish the relative soil characteristics and are used to help determine how productive a soil is based on National Resources Conservation Service (NRCS) procedures of soil classifications. Soil production potential and productivity ratings depend on a specific indicator crop or crops based on farmer obtained yields with these crops. When several indicator crops are used to help determine ratings, gross returns or net returns on a farm can be used to help create an equal scale for classification. The soil production potential rating system is based on using net return of a specified indicator crop so that soil limitations are less of a factor. The net return is defined as gross return minus management costs. However, in order for this system to work, it needs to be recalculated every few years in order to address changes with commodity prices. The net return is based on the soil classification maps. As seen in figure 1, the input costs and market prices are determined by a local LE committee for particular soil types for the area and then assigned a rating (Pease, 1996.). Although there may be some success using this rating system, the issue with this system is there is variability amongst the classifications because they are too broad as shown in figure 2 below.



Area Symbol: IA157, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	CSR2 Legend	Non-Irr Class *c	CSR2**	CSR
281B	Otley silty clay loam, 2 to 5 percent slopes	22.44	31.0%		IIe	91	91
281C2	Otley silty clay loam, 5 to 9 percent slopes, eroded	11.65	16.1%		IIIe	82	71
570C2	Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	10.63	14.7%		IIIe	72	68
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	8.84	12.2%		IVe	26	10
93D2	Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	7.42	10.3%		IIIe	44	25
11B	Colo-Ely complex, 0 to 5 percent slopes	5.12	7.1%		IIw	83	68
280	Mahaska silty clay loam, 0 to 2 percent slopes	4.11	5.7%		Iw	94	96
133	Colo silty clay loam, 0 to 2 percent slopes, occasionally flooded	2.18	3.0%		IIw	78	80
					Weighted Average	73.2	66.1

Area Symbol: IA157, Soil Area Version: 20

**IA has updated the CSR values for each county to CSR2.

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Figure 1. NRCS soil survey map showing variability across the landscape (reprinted by permission of AgriData, 2017).

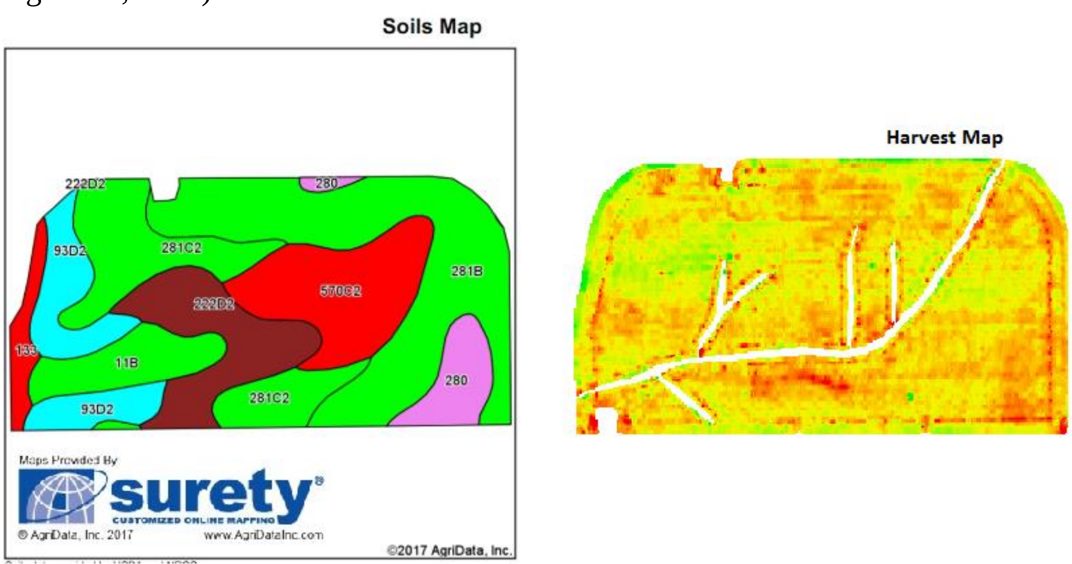


Figure 2. NRCS soil survey map (reprinted by permission of AgriData 2017) compared to a yield harvest map showing differences in variability.

Using generalized data is problematic because the resolution is too coarse to distinguish areas of opportunities for change. For example, creating variable rate seeding recommendations based on generalized data does not allow for opportunities to save seed or increase yield because the defined areas are too large to capture those minute opportunities. In addition, using generalized data does not significantly expose differences between producers and their management strategies. Consider two different producers, one focusing on input use efficiency strategies and decreased input costs compared to another who invests significantly in inputs and has costs that are above average for the region. Although yield level may be similar, profitability becomes a function of input cost.

Land Use Change

Land use change is complex as land use can and does change over time. External factors such as governmental policies or market prices complicate this issue because they alter incentives that in turn affect practices such using as particular cropping and/or management systems. Many environmental groups, economists, and ecologists think that governmental policies that stimulate agricultural production have negative environmental consequences, because more land is put into production (Lubowski 2006). As highly productive land becomes increasingly scarce, marginal producing land becomes more attractive for production. Economically marginal lands tend to be environmentally fragile, which is supported by previous research that provides evidence that sloping lands, as an example of fragile lands, are more susceptible to erosion than is less sloping land (Sanders). With this in mind, poorer soils typically require more nutrients to produce a desirable crop, if all other variables are equal. This means that there exists a greater risk for more soil and nutrient loss on these types of marginal soils (Lubowski, 2006.). If production occurs on marginal land because of high commodity prices or because governmental policies encourage increased production, negative environmental impacts along with risk of financial losses, can occur. Increased corn production in the upper Mississippi river basin has raised concerns over greenhouse gas emissions, biodiversity, air quality, soil erosion, and water quality. Many of these concerns stem from awareness brought on by water quality degradation and the Gulf of Mexico hypoxia research (Secchi, 2011). Another example of a negative impact due to production on marginal land can be seen in the Western Corn belt. Conversion of grassland to cropland is having a negative impact on bird diversity as populations of grassland nesting birds are declining due to grassland conversion to row crops to capture high commodity prices (Wright, 2013) (Table 2).

Year	1982	1992	2002	2010
Land Use				
Hayland (Acres Thousands)	14085	13946.6	13233.6	9851.9
Pastureland (Acres in Thousands)	2108.6	1789.5	2585.1	1541

Table 2. NRCS Hayland and Pastureland acre inventory from 1982-2010 in U.S. (United States Department of Agriculture, 2013)

Federal crop insurance policies also mitigate the risk of bringing marginal cropland into production (Wright, 2013). In the mid 1990's, increased crop insurance subsidies motivated U.S. farmers to expand cropland by 2.5 million acres. The majority of this land was previously pasture or grassland, and by 1997, annual wind and erosion increased by 1.4% and .9% respectively (Lubowski, 2006.). In much of the Western Corn Belt, grassland conversion rates to corn/soybeans are comparable to deforestation rates in the Brazil, Malaysia, and Indonesia (Wright, 2013). Increased crop insurance protection encouraged farmers to grow crops on land that carries more profit risk for that area. For example, federal crop insurance has incentivized farmers to plant crops in the Western corn belt where the climate is characterized by a mean annual evapotranspiration that exceeds mean annual rainfall, which creates drought stress conditions (Wright, 2013). According to Lubowski (2006), "Small positive and statistically significant increases in corn acreage appear to occur as participation in the corn insurance program increases, though the magnitudes of these increases are very small." Many of the acres converted to cropland would not be economically viable if it was not for subsidized insurance (Lubowski, 2006.). In other words, current federal crop insurance programs have promoted incentives to grow crops in environments that have unstable profitability and that have elevated risks of soil erosion and of making disproportionate contributions to water quality degradation. Mitigating the risk on marginal lands without increasing sustainable practices on those lands due to the use of crop insurance needs to be reevaluated.

Profitability

The final factor affecting conservation practice use is profitability. Producers understand profitability well. The more profitable a business is, the higher the return on investment and the more money that can be distributed to the shareholders. However, if a business is not profitable then there are multiple financial consequences such as decreased cash flow, increased loans, and the possibility of losing the business. How producers measure profitability can have a major impact on how they view their agricultural ventures (Hofstrand, 2009.) Producers may view their profitability based on several factors; however, most producers view their profitability on large scale factors such as whole farm operations or field level profitability. With this in mind, many producers fail to increase their overall profitability because they fail to consider utilizing small scale factors, such as managing land areas based on production potential. If producers considered viewing profitability at sub acre land parcels or smaller, their views would likely change. This would allow producers to understand their land and adjust their management practices to become more profitable for a given field.

When you examine the relationship between land use, land use change, and profitability there is potential to increase conservation, and increase profitability. However, to capture this potential, producers must look through a different lens. By viewing profitability in sub acre parcels of land, producers will likely recognize more opportunities. Based on this, management decisions made at a finer resolution may make huge impacts on conservation and profitability. As coach John Wooden once said, “It's the little details that are vital. Little things make big things happen.”(Howes, 2012).

CHAPTER IV

MATERIAL AND METHODS

To understand the impact of analyzing land units on a subfield scale and its effects on profitability, the use of a raster map is needed. Creating a raster map using harvest yield data allows for a clear visual analysis and financial numerical analysis to be applied to the raster to help distinguish profitable land units from non-profitable land units on the same field. This process also allows us to identify changes that could increase profitability. To create this raster map for this study, I used a common technique used by large producers to collect yield data maps from a combine monitor. However, instead of simply creating a yield map, I used this data in ArcGIS to create a raster map. By applying a financial equation of bushels per 4 square meters times commodity price minus all input cost to the raster map in ArcGIS, I was able to create a profitability map. Next, I was also able use the same equation in a modified form to understand how eliminating all input cost except land cost could affect profitability. It is imperative to create a profitability map so that producers can capture opportunities to increase their profitability while also remaining sustainable both financially and environmentally.

I worked with a cooperator who had a John Deere 2030 yield monitor installed in his combine and had access to the financial input data for his operation. I was able to extract the text and shape files (yield maps) from the monitor and import them into ArcGIS. Since the 2030 monitor records a yield reading every second, the yield maps needed to be put into a raster file. A raster file is composed of many same-sized pixels. Without doing this, each data point had varying areas assigned to it depending on the speed at which the combine was harvesting. I utilized the Geographical Information System (GIS) team at Iowa State University to help convert the data to a raster using ArcGIS's raster creation software. Each raster cell is 2 meters by 2 meters or 4 square meters respectively, based on the suggestion given by the GIS team. In the raster creation process, to eliminate false readings yields that did not fall within 1-400 bushels/acre were eliminated. Using the ArcGIS raster calculator, each pixel or yield data point was then converted from a bushel per acre figure that is given as output from the monitor to bushel per four square meter yield. This was done by determining the acre percent of four-square meters and then multiplying the bushels by this percentage, in this case the percentage is .0988%. Then the bushels per raster cell were multiplied by the respective commodity price to find the gross return per raster cell. The total fixed and variable costs per raster cell were then subtracted from the gross return to obtain the net profitability per raster cell.

(Bushels per Acre * .000988 * Commodity Price) – Total Cost per 4 Square Meters = Net Profitability per 4 Square Meters

Area within a field losing money was obtained by summing the areas of raster cells that had a negative financial return. Net loss was obtained by summing the results obtained with the above equation across all raster cells that had a net negative return. Had these areas been unfarmed, field profit would have increased equivalent to the net loss observed. To understand how only variable cost plays a role in profitability, the total number of raster cells that had a negative financial returned were tallied then multiplied by the total variable cost per raster which is the amount of money saved by not farming these areas. While variable costs are included in the profit/loss calculations, the potential environmental impact of inputs - fertilizers, pesticides, fuel consumption- and water runoff/soil erosion associated with farming these areas is not.

This project was conducted with 2014 and 2016 yields, since crop types were the same in each field. A complete financial input list and the summary of that data can be found in the Appendices. Appendix A has all financial input data by field and year. Appendix B has all fields by year, crop, and commodity price showing how many acres were profitable, breakeven, and un-profitable and the respective gross income per category. Appendix C has all color scale profitability maps by year, crop and commodity price showing areas of the field that were profitable, breakeven, or un-profitable. Financial data included the following fixed and variable inputs: costs associated with land, seed, fertilizer, herbicide, nitrogen, lime, fungicide, crop insurance, equipment, and drying. Two different price points per bushel for corn as well as soybeans were used to simulate various market prices. For corn, the commodity prices were set at $3.50 and $5.50/bu and in soybeans the price $9.00 and $11.00/bu. The output data is the net profitability per 4 square meters. This data is represented as a color-coded profitability map divided into three categories, loss, breakeven, and profit and are colored red, yellow, and green on the maps respectively. Although there are standard curves for raster color versus grain yield, for this project we currently do not have access or permission to these curves because this software is proprietary to ERSI which owns ArcGIS. The GIS team and I contacted ERSI to ask for permissions, but they were not granted. The raster map data was exported to excel so that is could be summarized numerically. The numerical data is divided into three categories of loss, breakeven, and profit. Within each category the total number of acres that falls within in that category is added together. Based on those acres, a percentage is assigned to each category by dividing the specified category acres by the total acres of the field. Each net profitability data point within the respective categories is also added, resulting in total dollars lost, null, or gained, as described above. A minimum, maximum, and median net profitability per four square meters by field and commodity price is also given as a frame of reference for the ends of the spectrum.

CHAPTER V

RESULTS

The overall findings show that the fields were not profitable, especially for soybeans. For corn, the profitability varied depending on land value, commodity price and year (Table 3). With soybean acres for 2014 and 2016, soybeans at $9.00 were profitable on only 29% of the acres. Increasing the soybean commodity price to $11.00 increased profitability to 50% of the acres. All corn acres for both years were only 38% profitable at $3.50, but at $5.50 98% of those acres were profitable.

Summarized Acre Data by Crop, Year, Price				
Crop & Price		**2014 Acres**	**2016 Acres**	**2014 & 2016 Acres**
Soybeans @ $9.00	**Loss**	**65%**	**79%**	**71%**
	Breakeven	**0%**	**0%**	**0%**
	Profit	**35%**	**21%**	**29%**
Soybeans @ $11.00	**Loss**	**47%**	**51%**	**49%**
	Breakeven	**1%**	**1%**	**1%**
	Profit	**52%**	**48%**	**50%**
Corn @ $3.50	**Loss**	**91%**	**22%**	**62%**
	Breakeven	**0%**	**1%**	**0%**
	Profit	**9%**	**77%**	**38%**
Corn @ $5.50	**Loss**	**2%**	**1%**	**2%**
	Breakeven	**0%**	**0%**	**0%**
	Profit	**98%**	**99%**	**98%**

Table 3. Summary of All Acres. Crop and corresponding commodity price can be found in the far-left column. The percentage of acres falling into each category of loss, breakeven, or profit by year can be found in the other columns.

Table 4 illustrates summarized data for a specific farm, year, crop and price.

Farm A Corner 2014 Soybeans @ $9.00			
Min	-$0.62		
Max	$2.50		
Median	$0.06		
Ranges	Acres	Percentage	$
Loss	62.48	94.11%	-10215.8
Breakeven	0.07	0.10%	0
Profit	3.84	5.79%	667.527
Total	66.39		-9548.3

Table 4. Example of data set results giving farm, field, year, crop, and commodity price. The min, max, and median net profitability per 4 square meters is shown. The number of acres, percentage of acres, and dollar amounts that fall into each category of loss, breakeven, and profit are shown as well as total acres and dollars profit or loss by field.

The color scale maps generated from ArcMap are categorized as red, yellow, and green representing a loss, breakeven, and profit respectively. This color scale map of Farm A Corner can be seen below in figure 3.

Figure 3. Example of a color scale profitability map generated in ArcMap showing either profitable (green), loss (red), or breakeven (yellow) units of land.

When comparing fixed cost variables such as land values, whether owned or rented, the profitability increased as land costs decreased. In Table 5 below, Farm B Home and Farm C East are both owned outright. With no associated fixed cost of land, these fields are extremely profitable (90% or higher) even at lower commodity prices. However, Farm A West and Farm A Corner are considerably less profitable (6-7% of the acres profitable), with the only difference being $300.00 cash rent on these two fields.

Farm B Home 2014 Soybeans @ $9.00			
Min	-$0.30		
Max	$2.81		
Median	$0.42		
Range	Acres	Percentage	$
Loss	11	9%	-$571
Breakeven	0	0%	$0
Profit	112	91%	$15,885
Total	124		$15,315

Farm C East 2016 Soybeans @ $9.00			
Min	-$0.24		
Max	$1.03		
Median	$0.22		
Range	Acres	Percentage	$
Loss	0	1%	-$19
Breakeven	0	0%	$0
Profit	36	99%	$8,342
Total	36		$8,323

Owned Land profitability high lighted in green on these fields.

Farm A West 2016 Soybeans @ $9.00			
Min	-$0.58		
Max	$1.09		
Median	-$0.13		
Range	Acres	Percentage	$
Loss	83	93%	-$12,948
Breakeven	0	0%	$0
Profit	6	6%	$270
Total	89		-$12,677

Farm A Corner 2016 Soybeans @ $9.00			
Min	-$0.58		
Max	$1.45		
Median	-$0.03		
Range	Acres	Percentage	$
Loss	63	92%	-$7,879
Breakeven	0	0%	$0
Profit	5	8%	$383
Total	68		-$7,496

Rented land profitability high lighted in red on these fields.

Table 5. Owned Acres (Green Highlight) vs Rented Acres (Red Highlight) Soybeans at $9.00 commodity price.

Land value affecting profitability can also be seen in Table 6 below, specifically when comparing land rental rates. Farm A East in 2016 was rented at $300.00 an acre vs. Farm D West at $250.00 an acre. The $50 reduction in cash rent increased profitable acres by 12% in 2016 with a $9.00 soybean price.

Farm D West 2016 Corn @ $3.50			
Min	-$0.68		
Max	$0.65		
Median	$0.00		
Range	**Acres**	**Percentage**	**$**
Loss	10	16%	-$979
Breakeven	0	0%	$0
Profit	55	84%	$5,830
Total	66		$4,851

Land rental rate at $250 an acre and profitability at 84%

Farm A East 2016 Corn @ $3.50			
Min	-$0.76		
Max	$0.57		
Median	-$0.08		
Range	**Acres**	**Percentage**	**$**
Loss	21	28%	-$1,744
Breakeven	1	1%	$0
Profit	54	71%	$3,005
Total	76		$1,261

Land rental rate at $300 an acre and profitability at 71%

Table 6. Corn Profitability Determined by Land Values. Farm A East is rented at a higher rate than Farm D West decreasing profitability.

Certain areas of fields were consistently unprofitable in this project. Areas of unprofitability varied year to year, yet the same areas were apparent across years. Figures 4, 5, and 6 all show there are areas of the field that are consistently losing money.

Figure 4. Profitability map of Farm B Home generated in ArcMap showing correlated areas of loss across multiple prices points circled in black.

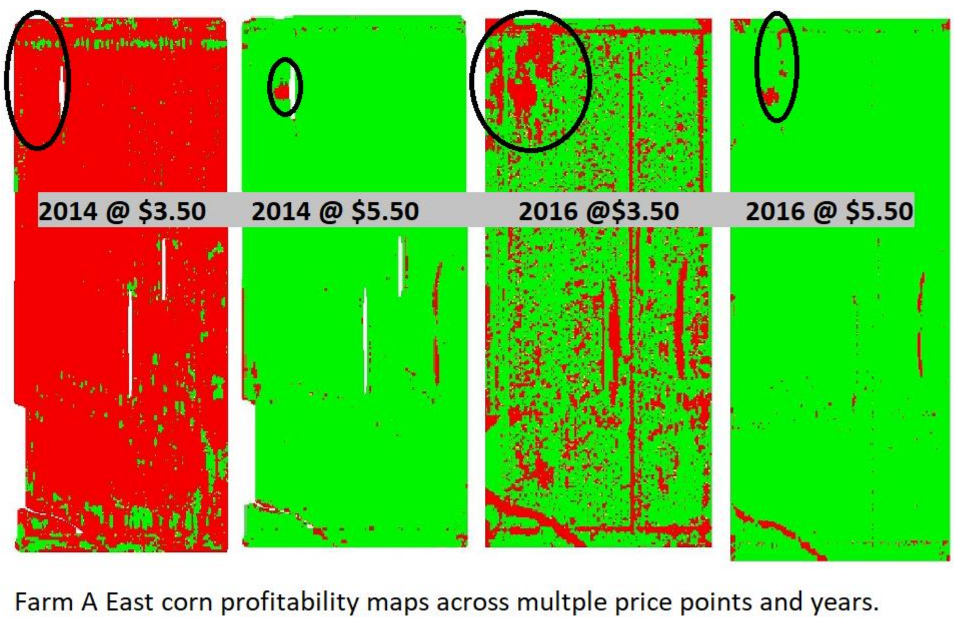
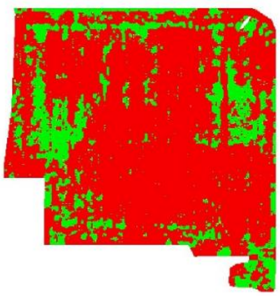


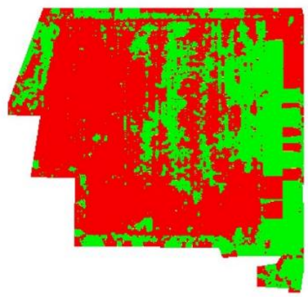
Figure 5. Farm A East corn profitability maps across multiple years and prices points. There are areas that consistently lose money such as the red areas circled in black.

Farm A West 2014 Soybeans @ $11.00			
Min	-$0.64		
Max	$3.37		
Median	$0.06		
Range	Acres	Percentage	$
Loss	66	78%	-$9,537
Breakeven	1	1%	$0
Profit	18	21%	$1,456
Total	85		-$8,081

Farm A West 2016 Soybeans @ $11.00			
Min	-$0.58		
Max	$1.46		
Median	-$0.02		
Range	Acres	Percentage	$
Loss	56	63%	-$6,135
Breakeven	1	1%	$0
Profit	32	36%	$2,565
Total	89		-$3,570



Farm A West 2014 Soybeans
@ $11.00 Profitability Map



Farm A West 2016 Soybeans
@ $11.00 Profitability Map

Figure 6. Farm A west profitability chart and profitability map showing the number of acres unprofitable as well as where those acres exist within the field. Profitable acres are highlighted in green and unprofitable acres are highlighted in red.

Table 7 exemplifies eliminating all variable input costs for the areas that were unprofitable from Farm A East for 2016 yield data at the $5.50 corn commodity price. Although this field overall was profitable, by eliminating those variable input cost on unprofitable areas the net revenue of the field increased by $249.41.

Farm A East 2016 Corn @ $5.50					After Eliminating Units of Land Losing Money	
Min	-$0.75					
Max	$1.34					
Median	$0.32					
Range	**Acres**	**Percentage**	**$**		**Total Number of Raster Cells Negative**	$509.00
Loss	1.37	2%	-$279.61			
Breakeven	0.02	0%	$0.00		**Variable Cost Per Raster**	$0.49
Profit	74.55	98%	$36,491.88			
					Total $ Saved	$249.41
Total	75.93		$36,212.27		**Net Field Revenue**	$36,461.68

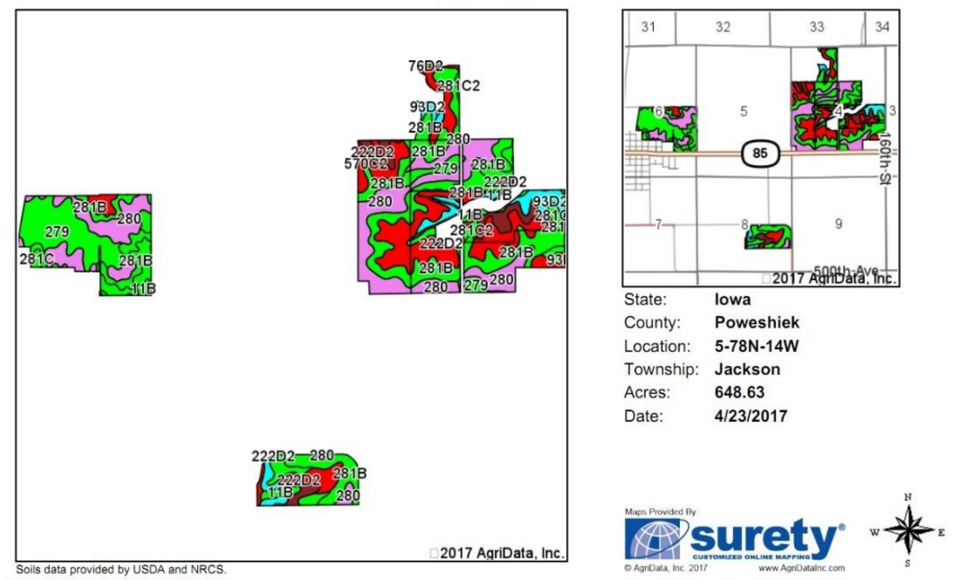
Table 7. Net field revenue before (Red Box) and after elimination (Green Box) of areas losing money on Farm A East 2016 corn @ $5.50. Blue box represents total dollars added to net field revenue

CHAPTER VI

DISCUSSION AND CONCLUSION

The land chosen for this data set with multiple fields is highly productive ground with a combined average Corn Suitability Rating (CSR) of 77.1, yet yield variability exists, see soil maps in Figure 7.

Soils Map



Area Symbol: IA157, Soil Area Version: 20

Code	Soil Description	Acres	Percent of field	CSR2 Legend	Non-Irr Class *c	CSR2**	CSR	Corn	Oats	Soybeans
281B	Otley silty clay loam, 2 to 5 percent slopes	170.28	26.3%		IIe	91	91			
280	Mahaska silty clay loam, 0 to 2 percent slopes	138.16	21.3%		Iw	94	96			
570C2	Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	128.35	19.8%		IIIe	72	68			
279	Taintor silty clay loam, 0 to 2 percent slopes	76.18	11.7%		IIw	83	89			
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	34.43	5.3%		IVe	26	10			
93D2	Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	33.95	5.2%		IIIe	44	25			
281C2	Otley silty clay loam, 5 to 9 percent slopes, eroded	31.52	4.9%		IIIe	82	71			
281C	Otley silty clay loam, 5 to 9 percent slopes	17.37	2.7%		IIIe	85	76	7	3	2
11B	Colo-Ely complex, 0 to 5 percent slopes	14.28	2.2%		IIw	83	68			
133	Colo silty clay loam, 0 to 2 percent slopes, occasionally flooded	2.18	0.3%		IIw	78	80			
76D2	Ladoga silt loam, 9 to 14 percent slopes, eroded	1.26	0.2%		IIIe	49	56			
76C2	Ladoga silt loam, 5 to 9 percent slopes, eroded	0.67	0.1%		IIIe	75	66			
					Weighted Average	**80.1**	**77.5**	**0.2**	**0.1**	**0.1**

**IA has updated the CSR values for each county to CSR2.

*c: Using Capabilities Class Dominant Condition Aggregation Method

Soils data provided by USDA and NRCS.

Figure 7. NRCS soil survey map showing all fields within dataset (reprinted by permission by Agridata 2017).

During the 2014 and 2016 growing seasons, this operation had produced record yields due to favorable weather patterns in this location, which may be a limitation to the data set. Considering the high productivity of these fields with favorable weather conditions, the lack of profitability seems problematic. Both highly productive land and favorable weather conditions should have promoted profitability; however, the results of this study, contradict this idea. In 2014, for Farm A West there were approximately 66 acres that were unprofitable to farm, even at the higher soybean commodity price of $11.00. In 2016, which was a better year overall for total field yield, there was still approximately 55 acres that was not profitable. If the grower was able to spatially determine spatial profitability over several years using visual profitability maps, this would allow producers to manage their land differently by understanding overall profit trends on their land. Growing different crops on those acres, or perhaps putting those acres into a government program such as the conservation reserve program could be a solution to concurrently increasing profitability and conservation. Crop diversification shows great promise for both increasing conversation and profitability. A field study done in Iowa from 2003-2011 showed that cropping system diversification enhanced not only yields of corn, soybeans and a biomass crop such as hay, but still maintained economic returns similar to a corn soybean rotation (Davis, 2012).

Although it is not possible to put 4 square meters of land into governmental programs, multiple units are often next to each other, adding up to potential acres that could become eligible for certain programs. As society improves their understanding of managing smaller land units, governmental programs, equipment, and technology will eventually adapt to create more solutions on a smaller scale. Other researchers have suggested that placing perennial crops or land cover in strategic locations within a field would add ecological and social economical value beyond what traditional crops could provide (Asbjornsen, 2013.). This notion is also supported by a model created by David Muth (2014) which subdivides a field into 100 square meter grids and then applied a 50-year profit average on those units. Based on his research, Muth (2014) concluded that by eliminating production (all inputs except cash rent) for the areas that were losing $250/acre or more, actually increased the field's profitability by $29/acre. A prime example of an area that should be considered for elimination of production in this research study would be on the Farm A East field, in the northwest corner. This area in the field has ponding issues that cannot be addressed without major expense to the grower due to the landscape position. Based on the results of this research project, even in high commodity price times, the area is still unprofitable. By eliminating all input cost except land rent from production on the non-profitable acres, the overall field profitability increases by $249.41.

By using profitability map trends, growers can predict their average commodity price which allows for profitability, hence creating a marketing strategy for future years. Using these profitability maps for predictions not only allows for marketing strategies to be formed, it also allows for changing crop type decisions to be made for rotation purposes. This would allow growers the ability to seek other markets for alternative crops. One limiting factor that was not included in the profitability calculations when the data was collected and analyzed in this study was the crop insurance payments the operation received. In 2014 alone, the entire operation received $70, 201.60 in subsidized crop insurance. Some of the subsidies were for parts of the land that was unprofitable, but many of the subsidies were targeted corn acres that were profitable. The cost to purchase crop insurance was part of the profitability calculations and accounted for approximately 4% of the total cost per acre. The harvest maps themselves are a limitation in that the yield calculated by the combine depend on how accurately the combine monitor is calibrated. This margin of error is difficult to calculate, but this equipment is what is commonly used currently.

Future research opportunities could include expanding profitability research into other crops, wetland reserve programs, conservation reserve programs, or other alternative uses to understand how those systems can increase profitability across an entire operation. Expanding the number of commodity price scenarios would also be beneficial to fully understand the breakeven point. This information would allow the grower to make a more informed decision regarding crop types, crop inputs, as well as marketing decisions based on spatial productivity within each field. Research on understanding how crop insurance payments affect profitability would also be beneficial to growers as well as for the government if changes to the system are being considered. Spatial differences on profitability vary across field landscapes, even on highly profitable farms. Although each producer has their own definition for marginal land, desired level of profitability, and level of involvement in government programs, there is a consensus that some land should not be farmed, being profitable is the goal of all business, and that government programs can be beneficial. There are many constraints to increasing the profitability of a unit of land while increasing conservation practices; such as markets for perennial crops, how we place a value on ecological/social economic benefits, and how to profit from that perceived value.

(Asbjornsen, 2013.) The increase use of newer technology occurring within the agriculture industry is improving the capability of software to view profitability in a user-friendly format. Although there are advancements in technology, there is a lack of educational resources for technology to be fully understood and used by producers. Many producers have expressed that they do not want, cannot afford, or cannot operate this new software, as well as the precision management tools to capture this data (Sparapani, 2017.). There also is a gap within government programs, specifically within the crop insurance realm that incentivizes farming unprofitable acres (Goodwin, 2012).

The saying "the devil is in the details" seems to hold true in life as well as for increasing profitability, decreasing crop insurance payments, and increasing our sustainability as a whole. If all producers and other parties involved with producers focus on the details of a field and move non-profitable acres to alternative uses that could improve overall profitably while helping conservation, producers will quickly improve all agricultural facets, including off-site impacts. Although this research study does not directly look at the benefits associated with analyzing a farm based on a spatial profitability to all parties involved, future research could focus on this to support the benefits of small-scale profitability and how it impacts other components such as the environment, consumers, and government. Although many solutions have been applied to profitability, production, and conservation, understanding the value of smaller land units compared to an entire field can help society understand and capture opportunities that could change the agricultural world in a positive manner.

References

AgriData. 2017. No Title. https://www.agridatainc.com/.

Asbojornsen, H., V. Hernadez-Santana, M.Z. Liebman, J. Bayala, and J. Chen. 2012. Targeting perennial vegatation in agriculutral landscapes for enchancing ecosystem services. Renew. Agric. Food Syst.: 1–25.

Committee, C.G.O.I.A.R.T.A. 1997. Report of the study on CGIAR research priorities for maginal lands.

Davis, A.S., J.D. Hill, C.A. Chase, A.M. Johanns, and M. Liebman. 2012. Increasing cropping systems diversity balances productivity, Profitability and Environmental Health. PLoS 7(10): e47149. https://doi.org/10.1371/journal.pone.0047149.

FAO. 2001. The economics of conservation agriculutre. http://www.fao.org/docrep/004/y2781e/y/2781e03.htm#P20_7481.

Good, K. 2017. 2018 Purdue university Outlook: Cash Rents, Farmland Values, Corn and Soybean Prices. Farm Policy News. http://farmpolicynews.ilinois.edu/2017/12/2018-purdue- university-outlook-cash-rents-farmland-values-corn-soybeans-prices/.

Goodwin, B.K., and V.H. Smith. 2003. An Ex Post Evaluation of the Conservation Reserve, Federal Crop Insurance, and Other Government Programs: Program Participation and Soil Erosion. J. Agrculutral Resour. Econ. 28(2): 201–216.

Goodwin, B.K., and V.H. Smith. 2012. What Harm Is Done By Subsizing Crop Insurance? Am. J. Agric. Econ. 95(2): 489–497.

Goodwin, B.K., M.L. Vandeveer, and J.L. Deal. 2004. An Empirical Analysis of Acreage Effects of Particpation in the Federal Crop Insurance Program. Am. J. Agric. Econ. 86(4): 1058–1077.

Hofstrand, D. 2009. Understanding Profitability. Iowa State Univ. Ext.: 1–6. https://www.extension.iastate.edu/agdm/wholefarm.html.c3-24.html (accessed 21 August 2015).

Howes, L. 2012. 10 Lessons For Entrepreneurs From Coach John Wooden. Forbes. https://www.forbes.com/sites/lewishowes/2012/10/19/10-lessons-for-entrepreneurs-from-coach-john-wooden/#c946b7516d54 (accessed 15 August 2018).

Lin, B.B. 2011. Resilience in agriculutre through crop diversification: adaptive managment for enviromental change. Biosci. Mag. 61(3): 183–193.

Lubowski, R.N., S. Bucholtz, R. Claaseen, M.J. Roberts, J.C. Cooper, A. Gueorguieva, and R. Johansson. 2006. Environmental Effects of Agirculutral Land-Use Change.

Miller, G., and M.J. Tidman. 2001. Impact of soil erosion on soil producvitiy. Iowa State Univ. Ext. http://www.ipm.iastate.edu/ipm/icm/2001/1-29-2001/soilerosion.html (accessed 2 July 2017).

Muth, D. 2014. Profitability versus encironmental performance: Are they competing? J. Soil Water Conserv. 69(6): 203A–206A.

Pease, J.R., and R.E. Coughlin. 1996. Land Evaluation and Site Assessment: A Guidebook for Rating Agricultural Lands, Second Edition.

Pierce, E. 2017. Food manufactureers, farmers, and consumers can change climate for good. https://www.supermarketnews.com/sustainability/food-manufacturers-farmers-and-consumers-can-change-climate-good.

Sanders, D.W. Sloping land: soil erosion problems and soil conservation requirements.

Secchi, S., P.W. Gassman, M. Jha, L. Kurkalove, and C.L. Kling. 2011. Potenital water quality changes due to corn expansion in the Upper Mississippi River Basin. Ecol. Soc. Am. 21(4): 1068–1084.

Sparapai, T. 2017. How Big Data And Tech Will Improve Agriculture, From Farm To Table. Forbes. http://www.forbes.com/sites/timsparapani/2017/03/23/how-big-data-and-tech-will- improve-agriculture-from-farm-to-table/#5d6bfba25989 (accessed 23 March 2017).

United States Department of Agriculture. 2013. Summary Report 2010 National Resources Inventory.

United States Department of Agriculture. 2015. Land Use. United States Dep. Agric. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/landuse (accessed 21 August 2015).

United States Department of Agriculture. 2017. NASS Survey of National Field Crops Totals.

Wright, C.K., and C. Wimberly, Michael. 2013. Recent land use change in the Western Corn Belt threatens grasslands and wetlands. Proc. Natl. Acad. Sci. 10(10): 4134–4139.

Appendix A.

Input Expense Report provided by Cooperator.

Crop Year 2014						
Farm Name	**Field Name**	**Acres**	**Crop**	**Total Cost/Acre**	**Total Field Cost**	***Cost Per 4 square Meter***
Farm A	Corner	67.73	Beans	$667.97	$45,241.61	$0.66
	Home West	89.3	Beans	$667.97	$59,649.72	$0.66
	Home East	76.78	Corn	$844.35	$64,829.19	$0.83
Farm B	Home	114.68	Beans	$317.97	$36,464.80	$0.31
Farm C	North	35.07	Beans	$642.97	$22,548.96	$0.64
	South	37.95	Beans	$642.97	$24,400.71	$0.64
	East	36.66	Beans	$317.97	$11,656.78	$0.31
	West	118.67	corn	$819.35	$97,232.26	$0.81
Farm D	West	261.86	corn	$794.35	$208,008.49	$0.79
Square Meters Per Acre			**4046.86**			
Crop Year 2016						
Farm Name	**Field Name**	**Acres**	**Crop**	**Total Cost/Acre**	**Total Field Cost**	***Cost Per 4 square Meter***
Farm A	Corner	67.73	Beans	$610.53	$41,351.20	$0.60
	Home West	89.3	Beans	$610.53	$54,520.33	$0.60
	Home East	76.78	Corn	$790.94	$60,728.37	$0.78
Farm B	Home	114.68	Beans	$310.53	$35,611.58	$0.31
Farm C	North	35.07	Beans	$635.53	$22,288.04	$0.63
	South	37.95	Beans	$635.53	$24,118.36	$0.63
	East	36.66	Beans	$310.53	$11,384.03	$0.31
	West	118.67	corn	$815.94	$96,827.60	$0.81
Farm D	West	261.86	corn	$740.94	$194,022.55	$0.73

Crop Year 2014																
Farm Name	**Field Name**	**Acres**	**Crop**	**Land Cost**	**Seed Cost**	**Fertiziler**	**Herbicide**	**Nitrogen**	**Lime**	**Fungicide**	**Crop Insurance**	**Equipement Cost**	**Drying Cost**	**Total Cost/Acre**	**Total Field Cost**	***Cost Per 4 square Meter***
Farm A	Corner	67.73	Beans	$350.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$667.97	$45,241.61	$0.66
	Home West	89.3	Beans	$350.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$667.97	$59,649.72	$0.66
	Home East	76.78	Corn	$350.00	$105.00	$40.80	$47.00	$108.00	$4.00	$28.00	$36.55	$100.00	$25.00	$844.35	$64,829.19	$0.83
Farm B	Home	114.68	Beans	$0.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$317.97	$36,464.80	$0.31
Farm C	North	35.07	Beans	$325.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$642.97	$22,548.96	$0.64
	South	37.95	Beans	$325.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$642.97	$24,400.71	$0.64
	East	36.66	Beans	$0.00	$71.00	$44.00	$43.00	$0.00	$4.00	$25.00	$30.97	$100.00	$0.00	$317.97	$11,656.78	$0.31
	West	118.67	corn	$325.00	$105.00	$40.80	$47.00	$108.00	$4.00	$28.00	$36.55	$100.00	$25.00	$819.35	$97,232.26	$0.81
Farm D	West	261.86	corn	$300.00	$105.00	$40.80	$47.00	$108.00	$4.00	$28.00	$36.55	$100.00	$25.00	$794.35	$208,008.49	$0.79
Square Meters Per Acre			**4046.86**													
Crop Year 2016																
Farm Name	**Field Name**	**Acres**	**Crop**	**Land Cost**	**Seed Cost**	**Fertiziler**	**Herbicide**	**Nitrogen**	**Lime**	**Fungicide**	**Crop Insurance**	**Equipement Cost**	**Drying Cost**	**Total Cost/Acre**	**Total Field Cost**	***Cost Per 4 square Meter***
Farm A	Corner	67.73	Beans	$300.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$610.53	$41,351.20	$0.60
	Home West	89.3	Beans	$300.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$610.53	$54,520.33	$0.60
	Home East	76.78	Corn	$300.00	$129.00	$35.40	$55.67	$93.73	$4.00	$0.00	$45.42	$100.00	$27.72	$790.94	$60,728.37	$0.78
Farm B	Home	114.68	Beans	$0.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$310.53	$35,611.58	$0.31
Farm C	North	35.07	Beans	$325.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$635.53	$22,288.04	$0.63
	South	37.95	Beans	$325.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$635.53	$24,118.36	$0.63
	East	36.66	Beans	$0.00	$78.20	$30.40	$47.48	$0.00	$4.00	$26.00	$24.45	$100.00	$0.00	$310.53	$11,384.03	$0.31
	West	118.67	corn	$325.00	$129.00	$35.40	$55.67	$93.73	$4.00	$0.00	$45.42	$100.00	$27.72	$815.94	$96,827.60	$0.81
Farm D	West	261.86	corn	$250.00	$129.00	$35.40	$55.67	$93.73	$4.00	$0.00	$45.42	$100.00	$27.72	$740.94	$194,022.55	$0.73

Appendix B.

Data Summary by field, year, commodity, and commodity price

Farm A Corner 2014 Soybeans @ $9.00			
Min	-$0.62		
Max	$2.50		
Median	$0.06		
Range	Acres	Percentage	$
Loss	62	94%	-$10,216
Breakeven	0	0%	$0
Profit	4	6%	$668
Total	66		-$9,548

Farm A Corner 2014 Soybeans @ $11.00			
Min	-$0.61		
Max	$3.21		
Median	$0.19		
Range	Acres	Percentage	$
Loss	43	65%	-$4,147
Breakeven	1	1%	$0
Profit	23	35%	$2,302
Total	66		-$1,845

Farm A Corner 2016 Soybeans @ $11.00			
Min	-$0.58		
Max	$1.90		
Median	$0.09		
Range	Acres	Percentage	$
Loss	35	51%	-$2,605
Breakeven	1	1%	$0
Profit	33	48%	$2,602
Total	68		-$4

Farm A Corner 2016 Soybeans @ $9.00			
Min	-$0.58		
Max	$1.45		
Median	-$0.03		
Range	Acres	Percentage	$
Loss	63	92%	-$7,879
Breakeven	0	0%	$0
Profit	5	8%	$383
Total	68		-$7,496

Farm A East 2014 Corn @ $3.50			
Min	-$0.80		
Max	$0.47		
Median	-$0.16		
Range	**Acres**	**Percentage**	**$**
Loss	70	93%	-$7,378
Breakeven	0	0%	$0
Profit	5	6%	$327
Total	75		-$7,050

Farm A East 2014 Corn @ $5.50			
Min	-$0.78		
Max	$1.22		
Median	$0.23		
Range	**Acres**	**Percentage**	**$**
Loss	1	2%	-$304
Breakeven	0	0%	$0
Profit	73	98%	$24,991
Total	75		$24,687

Farm A East 2016 Corn @ $3.50			
Min	-$0.76		
Max	$0.57		
Median	-$0.08		
Range	**Acres**	**Percentage**	**$**
Loss	21	28%	-$1,744
Breakeven	1	1%	$0
Profit	54	71%	$3,005
Total	76		$1,261

Farm A East 2016 Corn @ $5.50			
Min	-$0.75		
Max	$1.34		
Median	$0.32		
Range	**Acres**	**Percentage**	**$**
Loss	1	2%	-$280
Breakeven	0	0%	$0
Profit	75	98%	$36,492
Total	76		$36,212

Farm A West 2014 Soybeans @ $9.00			
Min	-$0.64		
Max	$2.64		
Median	-$0.04		
Range	**Acres**	**Percentage**	**$**
Loss	83	98%	-$17,255
Breakeven	0	0%	$0
Profit	2	2%	$361
Total	85		-$16,895

Farm A West 2014 Soybeans @ $11.00			
Min	-$0.64		
Max	$3.37		
Median	$0.06		
Range	**Acres**	**Percentage**	**$**
Loss	66	78%	-$9,537
Breakeven	1	1%	$0
Profit	18	21%	$1,456
Total	85		-$8,081

Farm A West 2016 Soybeans @ $11.00			
Min	-$0.58		
Max	$1.46		
Median	-$0.02		
Range	**Acres**	**Percentage**	**$**
Loss	56	63%	-$6,135
Breakeven	1	1%	$0
Profit	32	36%	$2,565
Total	89		-$3,570

Farm A West 2016 Soybeans @ $9.00			
Min	-$0.58		
Max	$1.09		
Median	-$0.13		
Range	**Acres**	**Percentage**	**$**
Loss	83	93%	-$12,948
Breakeven	0	0%	$0
Profit	6	6%	$270
Total	89		-$12,677

Farm D West 2016 Corn @ $3.50			
Min	-$0.68		
Max	$0.65		
Median	$0.00		
Range	**Acres**	**Percentage**	**$**
Loss	10	16%	-$979
Breakeven	0	0%	$0
Profit	55	84%	$5,830
Total	66		$4,851

Farm D West 2016 Corn @ $5.50			
Min	-$0.66		
Max	$1.43		
Median	$0.43		
Range	**Acres**	**Percentage**	**$**
Loss	1	1%	-$124
Breakeven	0	0%	$0
Profit	65	99%	$35,603
Total	66		$35,479

Farm B Home 2014 Soybeans @ $9.00			
Min	-$0.30		
Max	$2.81		
Median	$0.42		
Range	**Acres**	**Percentage**	**$**
Loss	11	9%	-$571
Breakeven	0	0%	$0
Profit	112	91%	$15,885
Total	124		$15,315

Farm B Home 2014 Soybeans @ $11.00			
Min	-$0.29		
Max	$3.50		
Median	$0.54		
Range	**Acres**	**Percentage**	**$**
Loss	4	3%	-$222
Breakeven	0	0%	$0
Profit	120	97%	$27,571
Total	124		$27,349

Farm C East 2016 Soybeans @ $9.00			
Min	-$0.24		
Max	$1.03		
Median	$0.22		
Range	**Acres**	**Percentage**	**$**
Loss	0	1%	-$19
Breakeven	0	0%	$0
Profit	36	99%	$8,342
Total	36		$8,323

Farm C East 2016 Soybeans @ $11.00			
Min	-$0.23		
Max	$1.32		
Median	$0.34		
Range	**Acres**	**Percentage**	**$**
Loss	0	0%	-$9
Breakeven	0	0%	$0
Profit	36	100%	$12,728
Total	36		$12,719

Farm C North 2014 Soybeans @ $9.00			
Min	-$0.63		
Max	$2.57		
Median	-$0.05		
Range	**Acres**	**Percentage**	**$**
Loss	34	96%	-$7,946
Breakeven	0	0%	$0
Profit	1	3%	$237
Total	36		-$7,709

Farm C North 2014 Soybeans @ $11.00			
Min	-$0.63		
Max	$3.29		
Median	$0.06		
Range	**Acres**	**Percentage**	**$**
Loss	30	85%	-$5,005
Breakeven	0	0%	$0
Profit	5	14%	$698
Total	36		-$4,307

Farm C North 2016 Soybeans @ $9.00			
Min	-$0.61		
Max	$0.97		
Median	-$0.18		
Range	**Acres**	**Percentage**	**$**
Loss	32	98%	-$5,865
Breakeven	0	0%	$0
Profit	1	2%	$36
Total	32		-$5,829

Farm C North 2016 Soybeans @ $11.00			
Min	-$0.61		
Max	$1.32		
Median	-$0.08		
Range	**Acres**	**Percentage**	**$**
Loss	25	79%	-$3,001
Breakeven	0	1%	$0
Profit	7	21%	$428
Total	32		-$2,573

Farm C South 2014 Soybeans @ $9.00			
Min	-$0.62		
Max	$1.80		
Median	-$0.09		
Range	**Acres**	**Percentage**	**$**
Loss	36	95%	-$5,750
Breakeven	0	0%	$0
Profit	2	4%	$214
Total	37		-$5,536

Farm C South 2014 Soybeans @ $11.00			
Min	-$0.62		
Max	$2.34		
Median	$0.01		
Range	**Acres**	**Percentage**	**$**
Loss	22	59%	-$2,582
Breakeven	0	1%	$0
Profit	15	40%	$1,191
Total	37		-$1,391

Farm C West 2014 Corn @ $3.50			
Min	-$0.79		
Max	$0.53		
Median	-$0.12		
Range	**Acres**	**Percentage**	**$**
Loss	104	89%	-$12,606
Breakeven	0	0%	$0
Profit	12	11%	$975
Total	117		-$11,631

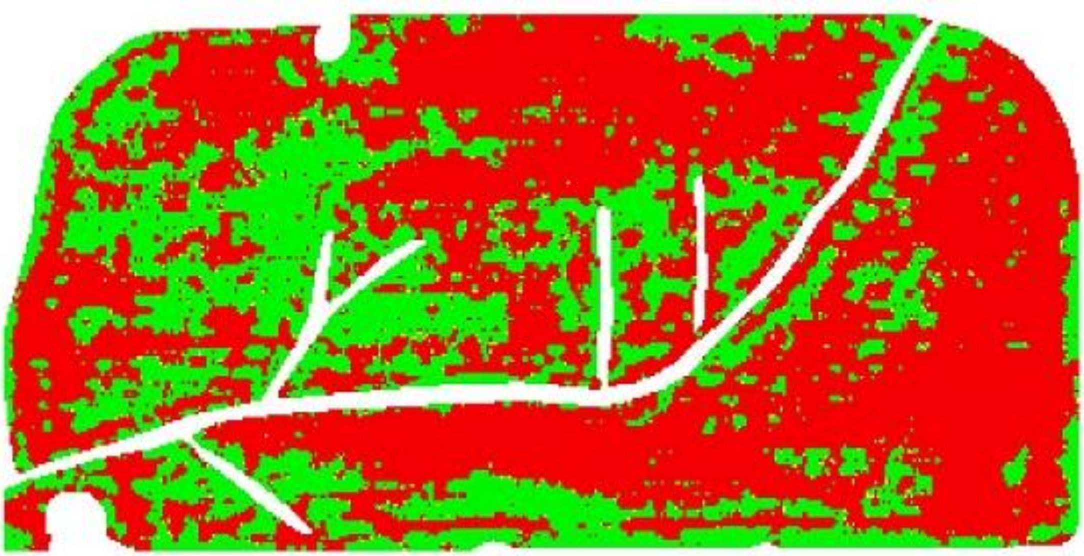
Farm C West 2014 Corn @ $5.50			
Min	-$0.78		
Max	$1.29		
Median	$0.29		
Range	**Acres**	**Percentage**	**$**
Loss	3	3%	-$468
Breakeven	0	0%	$0
Profit	114	97%	$36,880
Total	117		$36,412

Appendix C.

Profitability Color Scale Maps Generated in ArcMap.

Farm A Corner 2014 Soybeans @ $9.00

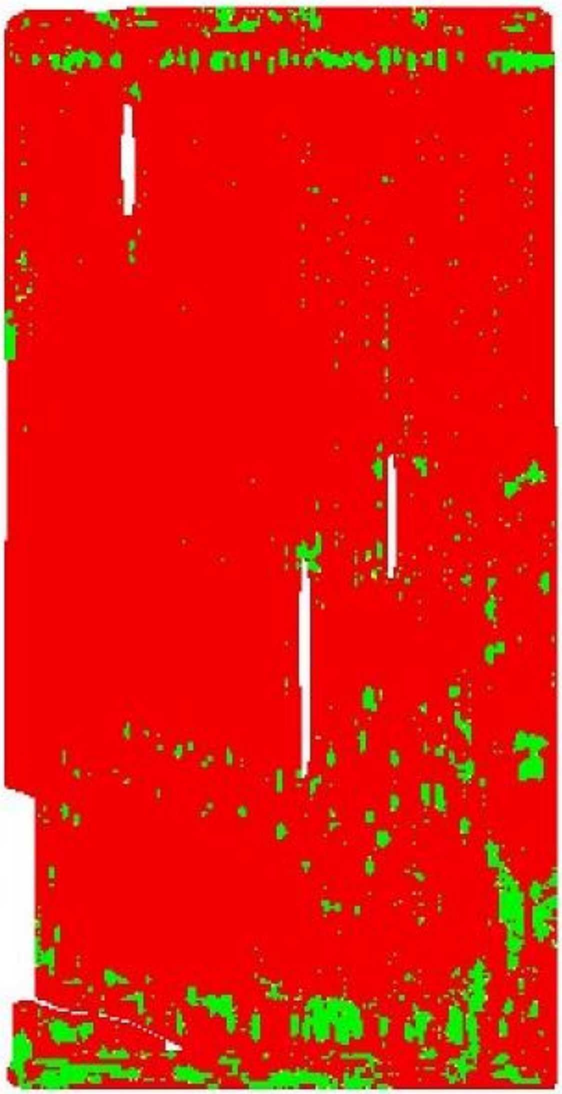
Farm A Corner 2014 Soybeans @ $11.00



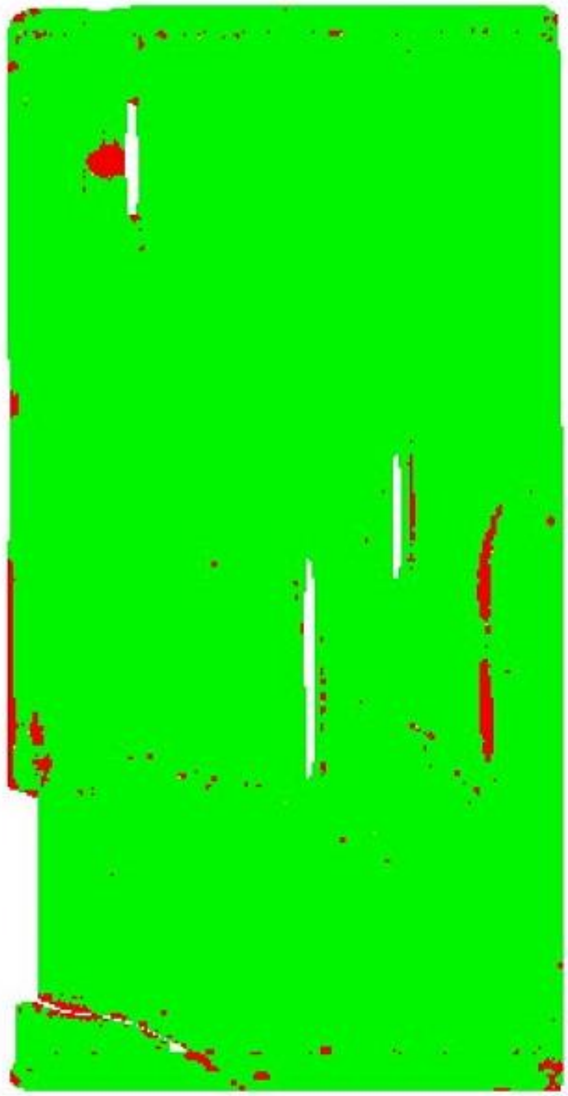
Farm A Corner 2016 Soybeans @ $9.00

Farm A Corner 2016 Soybeans @ $11.00

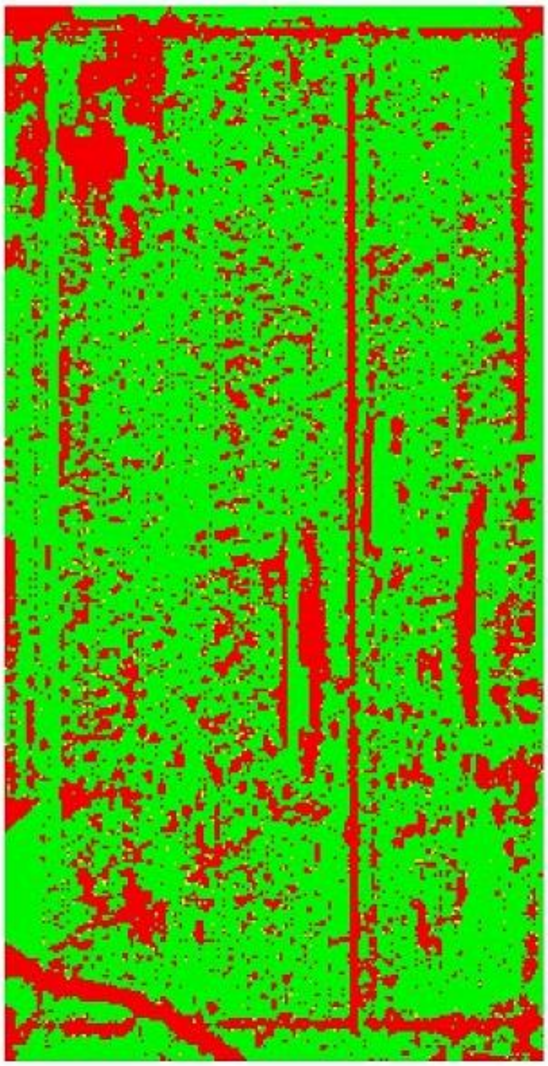
Farm A East 2014 Corn @ $3.50



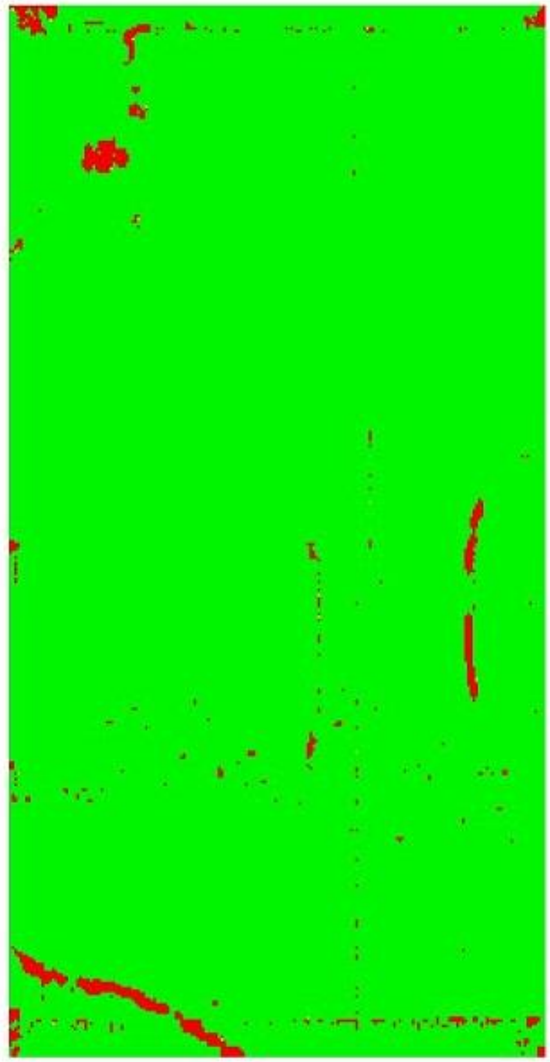
Farm A East 2014 Corn @ $5.50



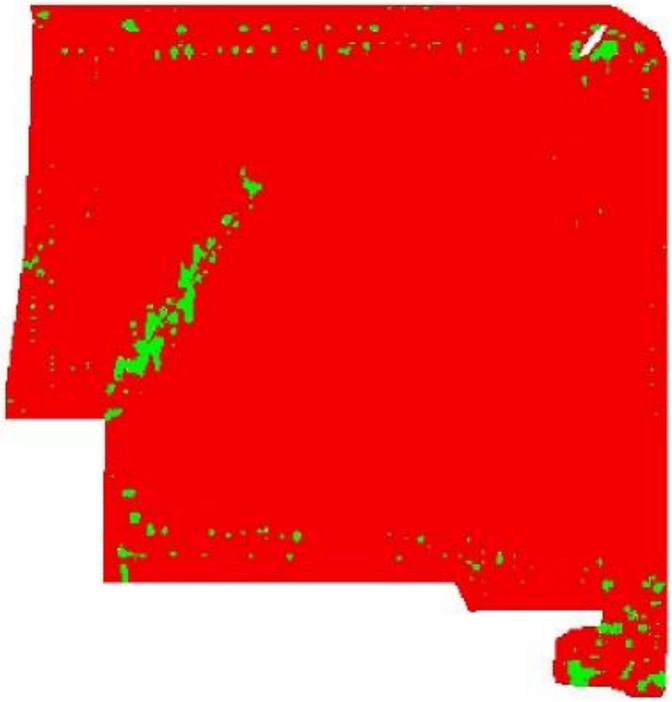
Farm A East 2016 Corn @ $3.50



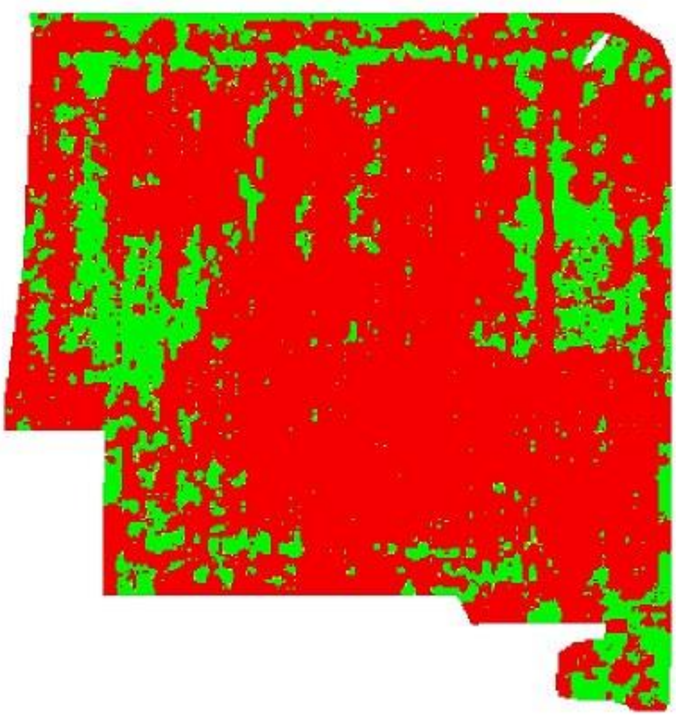
Farm A East 2016 Corn @ $5.50



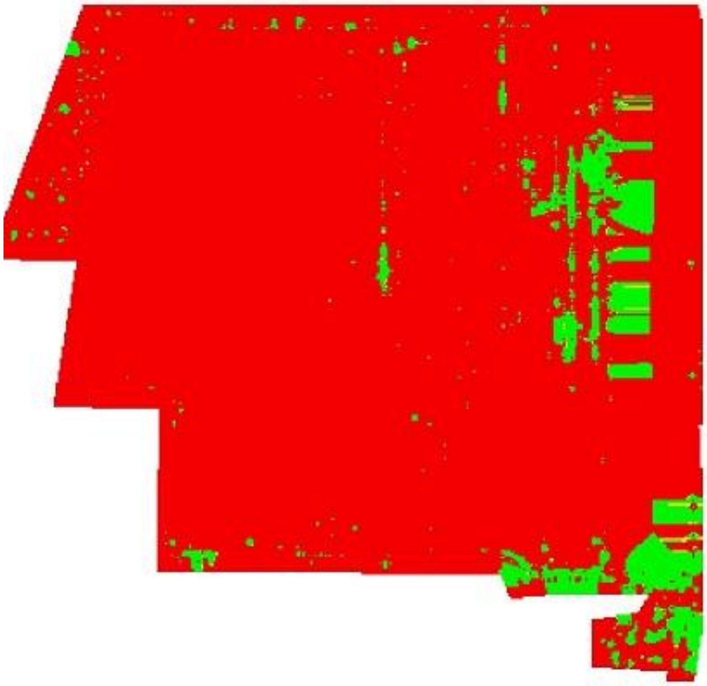
Farm A West 2014 Soybeans @ $9.00



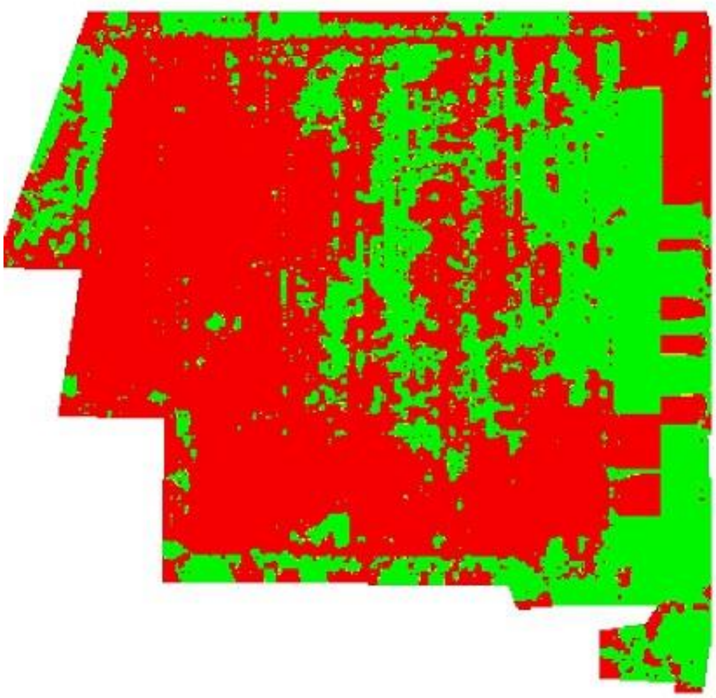
Farm A 2014 Soybeans @ $11.00



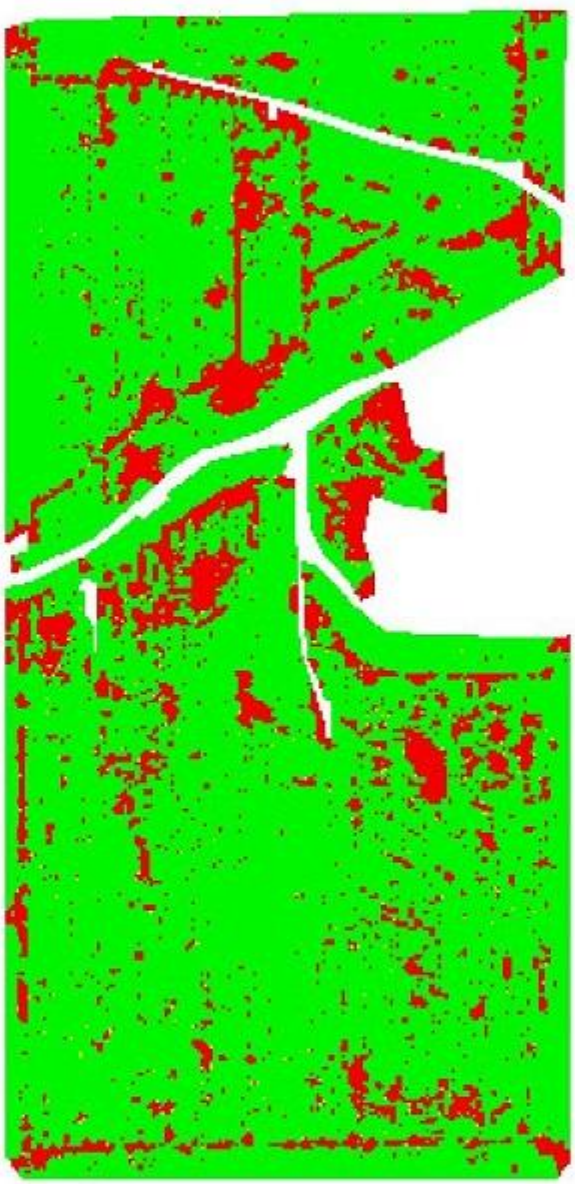
Farm A West 2016 Soybeans @ $9.00



Farm A West 2016 Soybeans @ $11.00

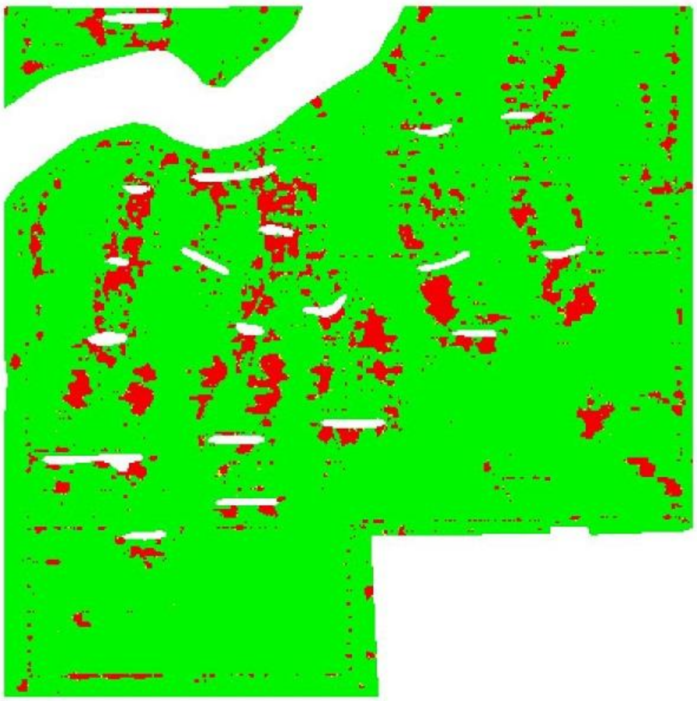


Farm D West 2016 Corn @ $3.50

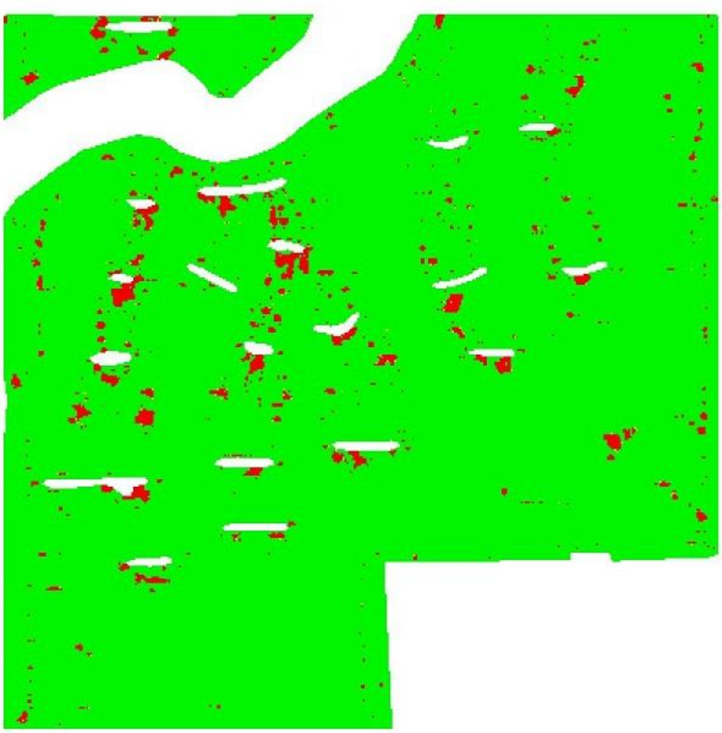


Farm D West 2016 Corn @ $5.50

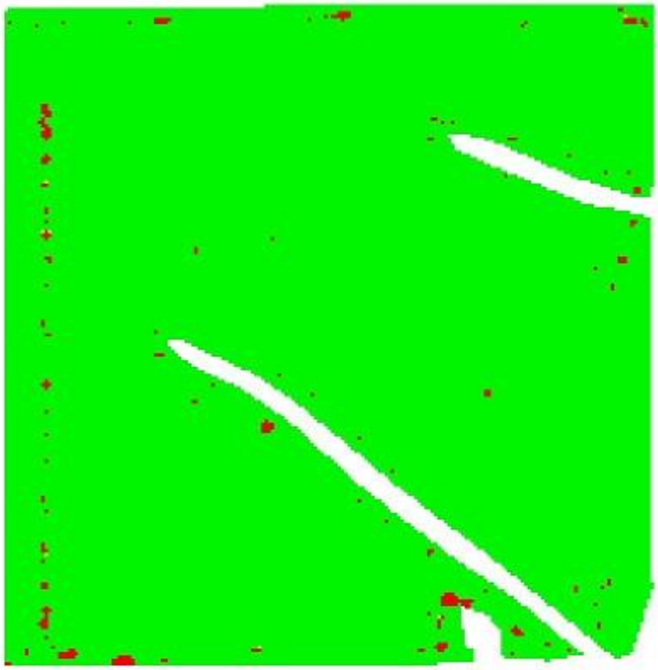
Farm B Home 2014 Soybeans @ $9.00



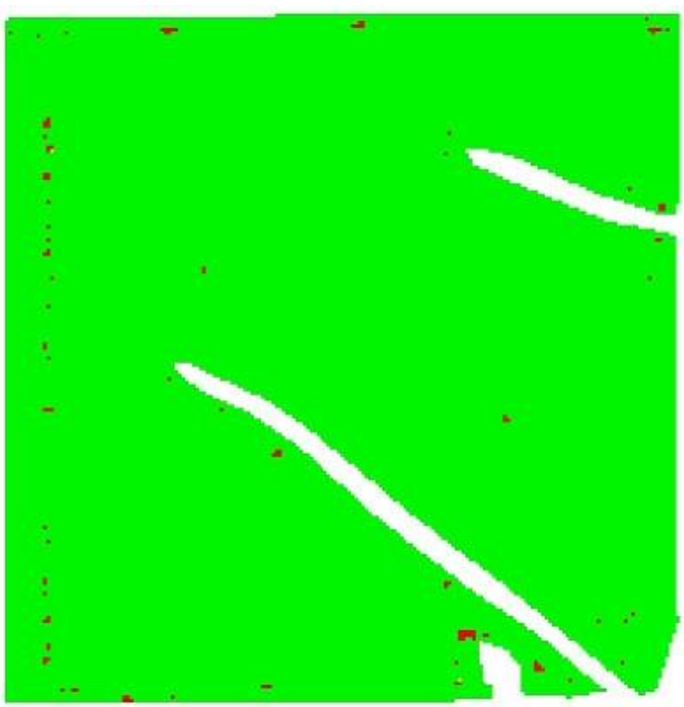
Farm B Home 2014 Soybeans @ $11.00



Farm C East 2016 Soybeans @ $9.00



Farm C East 2016 Soybeans @ $11.00

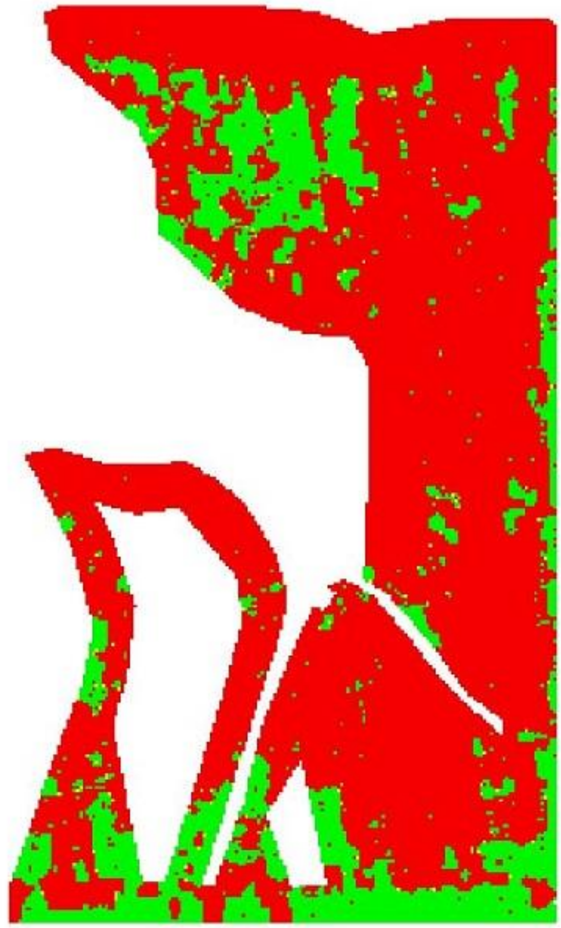


Farm C North 2014 Soybeans @ $9.00

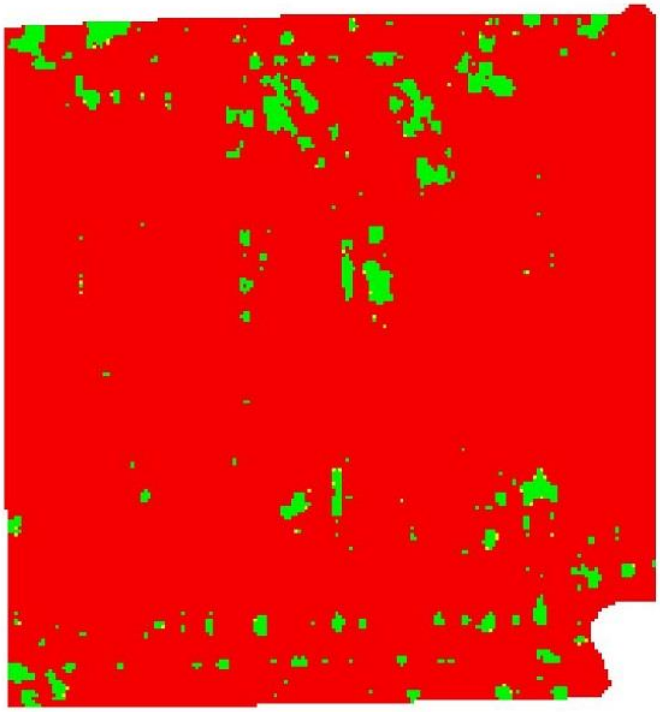
Farm C North 2014 Soybeans @ $11.00

Farm C North 2016 Soybeans @ $9.00

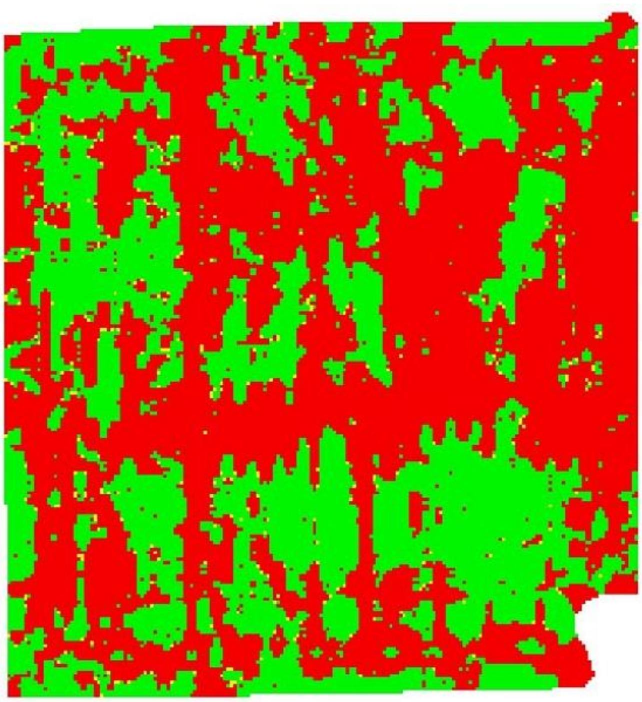
Farm C North 2016 Soybeans @ $11.00



Farm C South 2014 Soybeans @ $9.00



Farm C South 2014 Soybeans @ $11.00



Appendix D.

Permissions

Surety Map Permission:

RE: Information Request From AgriData Website Inbox ×

[redacted]
to me

Mon, Aug 27, 8:34 AM

Greetings Jon,
All we require you to do is make sure that the Surety logo is visible/legible on any page the maps are used. I have attached a stand-alone logo if you are not including the full pages produced from the software. Otherwise you may have permission to use the maps you generate for your paper. Good luck with your paper!
Sincerely,

[redacted]

Surety® Mapping Support Specialist

[redacted]

AgriData INCORPORATED

Adam@agridatainc.com
www.agridatainc.com

From: noreply@agridatainc.com <noreply@agridatainc.com>
Sent: Sunday, August 26, 2018 9:09 AM
To: info <info@agridatainc.com>
Subject: Information Request From AgriData Website

Name: Jon McWilliams
Company: H and J Fert
Address: 702 South Front St
City: Montezuma
State: IA
Phone: 319-541-7908
Fax: --
E-mail: mcwilliams.jon@gmail.com
I would like more info for:
Academic Institutions
Comments:
I am working on my master's of agronomy and used surety maps within my paper and cited etc. I need permission to include these images in the paper so it may be posted in the Iowa State University online Library. Thank you, Jon McWilliams

Grower Data Permission:

Jon McWilliams has permission to use all harvest data and financial data for farm's A,B,C, & D for this paper and any publications that may insure.

Sign and Date:
Brent James